



Hybu Cig Cymru  
Meat Promotion Wales

Lamb Producers' Handbook

# From gate to plate



## About HCC

Hybu Cig Cymru - Meat Promotion Wales (HCC) is the organisation responsible for the development, promotion and marketing of Welsh red meat. We work with all sectors of the Welsh red meat industry - from the farmers through to the retailers, to develop the industry itself as well as develop profitable markets for Welsh Lamb, Welsh Beef and pork from Wales.

This booklet forms part of a series of publications produced by HCC's Industry Development team.

The Industry Development team undertake a range of activities that include:

- Technology Transfer
- Research and Development
- Market Intelligence
- Training
- Benchmarking



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# Introduction

In this booklet, we have set out a series of guidelines on the selection of stock for the market that look at all aspects of the supply chain.

These begin with information on how to improve your livestock so that they best meet what the market demands, followed by how to assess that demand (using classification as a basis for the specification of market requirements), and how to target your production through good stock selection.

Once the market requirements have been understood and production adjusted accordingly, key marketing decisions have to be taken to achieve the best returns. It is essential for the producer to understand the terms and conditions under which the livestock are being sold, the factors that will affect the carcass weight and killing out percentage, and also the issues that will affect the eating quality of the meat and the yield from the butchery of the carcass into the cuts the consumer requires.

These are all underpinned by specific Technical Notes, which can be found at the back of the booklet.



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# Breed Improvement

The factors that influence livestock performance can be divided into those that are due to an animal's breeding potential as determined by its genes, and those due to the environment in which it is reared.



It is important to get both of these aspects of production right. This makes the selection of breeding stock extremely important.

It is not possible to identify breeding stock by eye alone. Performance records provide an essential tool in assessing breeding potential.

Estimated Breeding Values (EBVs) which help to identify breeding stock with superior genetic potential are now widely available.

Depending on the specific breeding objective, high index breeding stock will produce offspring which:

- Are more prolific
- Are heavier at weaning
- Grow faster
- Produce leaner carcasses, which can be taken to heavier weights without becoming over fat

Trials show that producers can improve the financial performance of their flocks by at least £3.50 per lamb through the selection of breeding stock with high indexes.

Selecting rams with good EBVs for Muscle Depth (muscularity), will improve the muscularity of carcasses and therefore, saleable meat yield. Improving such genetic potential should be exploited where there is no detrimental effect on meat quality.

*For more detailed information see Technical Note 1, page 25.*



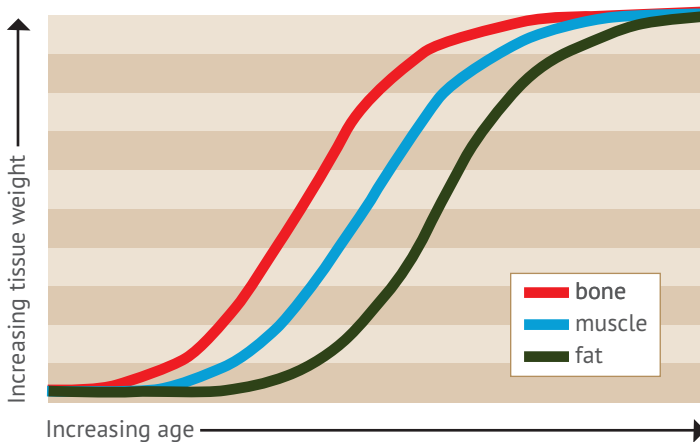
# Growth / Muscle Development

## The development of lean muscle and fat

The main purpose of rearing sheep today is the production of meat for human food. Meat comprises lean muscle with associated bone and fat.

As an animal grows the tissues grow and mature at different rates. For the three important components of the carcass, bone grows first, followed by muscle and then fat.

Growth of animal tissue



This means that the energy intake of an animal is first directed to bone growth and then to lean growth. Once the demands of these two tissues are met, excess energy is stored as fat.

Fat is energy dense and the energy cost is about six times that of depositing muscle. It is therefore important for cost effective animal production to match dietary supply with the need for lean tissue growth to produce lean meat required by the market.



### Carcase Classification

Systems of classification were principally set up as a means of improving the efficient operation of the market. Today they remain as basic aids to the more efficient and transparent trading of livestock and meat, forming the basis for the deadweight sale of sheep and enabling lamb and older sheep carcasses to be traded using a common language.

Classification of sheep carcasses is not regulated, unlike cattle and pigs, which are both covered by EU Regulations, but the industry has adopted the Sheep Carcase Classification Scheme, EUROP grid.

Classification has also been shown to be a good indicator of meat yield (which is the total percentage of saleable meat from a carcass, not to be confused with killing out percentage, which is the carcass weight as a percentage of the liveweight).

As a good average an R3L carcass will have a meat yield of about 80%, with yield rising by about 1% point for each move up a conformation or down a fat class, and falling by 1% point for each move down a conformation class or up a fat class.

*(For more details how production systems affect classification see Technical Note 2, page 26).*



## The basis of sheep classification

### CONFORMATION

The conformation class is determined by a visual appraisal of shape, taking into account the blockiness of the carcass and fullness of the legs, loin and shoulder. No adjustment is made for the influence of fatness on the overall shape.

There are five main classes: E,U,R,O,P (where E=excellent to P=poor), but traders in ewe carcasses may ask for class P to be divided into an upper (P+) and a lower (-P) band.

### FATNESS

The fat class is determined by a visual appraisal of external fat development. There are five main classes ranging from 1 (very lean) to 5 (very fat). Classes 3 and 4 are sub-divided into L (leaner) and H (fatter).

The conformation class is described first, followed by the fat class e.g. R3L.

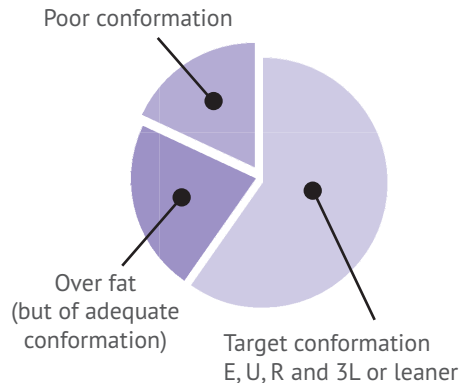
### CATEGORY

NSL are animals born and marketed within a year beginning on 1 January or born after the beginning of October in the year prior to marketing; OSL are other clean sheep with no permanent incisor teeth erupted and MS are clean sheep with one or more permanent incisor teeth erupted.

### The classification of sheep carcasses is based upon:

- the establishment/ verification of carcass weight (derived from a verified carcass dressing specification)
- visual appraisal of conformation and fatness
- category – new season lamb (NSL), old season lamb (OSL), mature sheep (MS), EWE and RAM
- age

### Distribution of Welsh lamb carcasses by classification result



# Target your Markets

**In order to obtain the best returns, producers need to:**

- Identify the market(s) for their sheep/lambs
- Understand what the market needs
- Assess their sheep/lambs against market needs and manage accordingly

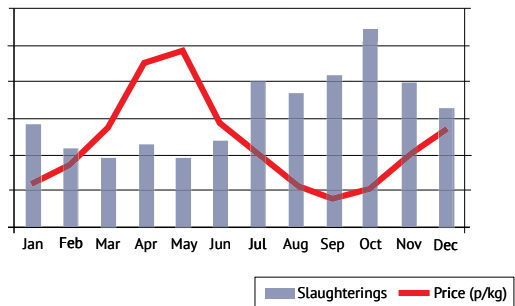
## Seasonal variation

The sheep market is affected by seasonal supply and demand. Returns improve when producers match production to market demand by adopting appropriate breeding and feeding policies.

By regularly monitoring how animals are progressing towards finish, it is possible to adjust feeding regimes to bring stock to market at the best time.

**Market information is vital and can be accessed online at [www.hccmpw.org.uk](http://www.hccmpw.org.uk).**

**Seasonal variation in sheep slaughtering and prices in Wales**



## Selecting for the market

The ability to assess sheep both visually, but most importantly by handling, is an essential skill for a sheep producer. It provides vital feedback to monitor the progress of animals, spot ailments and adjust feed regimes. By combining handling with regular weighing and recording, producers can manage their stock in order to maximise their returns.

Lambs should be carefully selected to ensure that as many as possible meet the specific market requirements.



## Typical market requirements

		Increasing fatness →						
		1	2	3L	3H	4L	4H	5
Improving conformation ↑	E	-20	+20	+20	base	-20	-30	-70
	U	-20	+10	+10	base	-20	-30	-70
	R	-30	base	base	-5	-25	-50	-70
	O	-50	-10	-10	-20	-40	-60	-70
	P	-70	-60	-60	-60	-60	-100	-100

Example of payment grid

The preferred classification for different markets is highlighted in red. For example, an R3L lamb of 16 to 21kg dressed carcass weight, would attract the supermarket base price and would be acceptable for the domestic markets, but lighter weights of 12 to 19kg are typically required for the export trade outside of the UK.

The requirements of the main 'generic' markets for a sheep/lambs producers are as follows:

**Supermarket**  
 Carcass weight: 16 to 21kg  
 Conf: E,U,R  
 Fat: 2,3L (some include 3H)

**Export Market**  
 Carcass weight: 12-19kg  
 Conf: E,U,R (some markets will take O)  
 Fat: 2,3L

**Traditional / Catering Butcher**  
 Carcass weight: 16-21kg dcw  
 Conf: E,U,R,O  
 Fat: 2, 3L,3H,4L

**Cull ewes**  
 A range of conformations are acceptable (R, O and even P), but fat levels should be 2 or 3L; lean cull ewes are in great demand for parts of the 'halal' market

A carcass of classification 3H however, would only be targeted by the traditional/catering butcher.

Sheep/lambs which are not well suited to any of the target markets attract the most severe price penalties e.g. this would be the case for conformation P and fat classes 4H and 5. Note also that some abattoirs will only pay on weights up to 21kg.

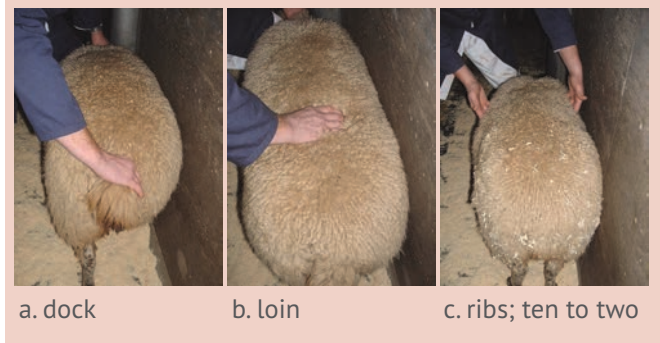
Wherever possible sheep/lambs should be presented in even batches, that are matched to specific market needs in terms of weight, conformation and fat. Mixed batches including some animals that do not meet the buyers specification will fail to get the best returns.

## Selecting Stock for Slaughter

To the trained eye, general appearance gives some guide to an animals level of finish, but for the best estimate this should be combined with handling and weighing.

### Assessing Fatness

Handling live sheep to assess fatness is an acquired skill which can be gained by regular practice. There are a number of important handling points on live sheep which provide reliable guides to the fat class of its carcase: the tail root or dock, the loin and the ribs (ten to two).

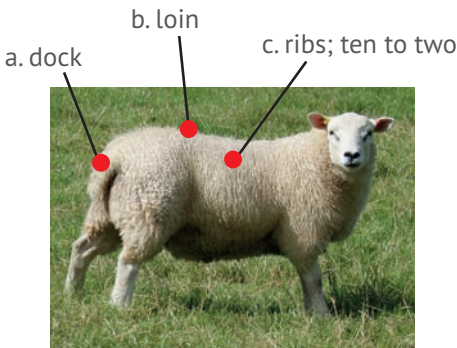


Handling provides a reliable assessment of fatness provided wool thickness is allowed for, but excessive pressure can lead to bruising. This leads to devaluation of the carcasses, so careful handling is important.

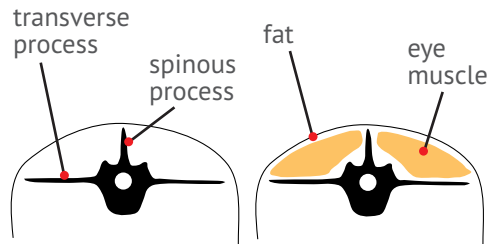
Perfecting selection skills can be profitable. Live handling, followed by a visit to examine the carcasses in the abattoir, is a good way to

gain experience and perfect the technique. Regular use of carcase classification provides a sound basis for monitoring selection decisions.

Further information and practical training on how to assess live animals is available through HCC.



*Handling points*



*Structure of loin*

## Key handling points to assess fatness for lamb

### DOCK

#### Fat class

- 1 Individual bones very easy to detect
- 2 Individual bones easy to detect with light pressure
- 3 Moderate pressure to detect individual bones
- 4 Firm pressure to detect individual bones
- 5 Individual bones cannot be detected.



### LOIN

#### Fat class

- 1 Very easy to feel between transverse processes which are very prominent
- 2 Prominent spinous and transverse processes felt easily
- 3 Tips of processes rounded. Individual bones felt as corrugations with light pressure
- 4 Spinous processes felt with moderate pressure – transverse processes with firm pressure
- 5 Individual processes cannot be felt.



### TEN TO TWO ON LAST TWO RIBS

#### Fat class

- 1 Individual ribs feel very bare, prominent and easy to detect
- 2 Individual ribs show slight cover but still easy to detect
- 3 Individual ribs have softer feel, with fat cover becoming more evident in between and over ribs, which are now less easy to detect
- 4 Individual ribs only detectable with firm pressure
- 5 Individual ribs undetectable, soft, rolling, spongy feel.



**Breast can also be used for assessment of higher fat class**

# 12 Selecting Stock for Slaughter

## Assessing Conformation

### Loin and Shoulder

<b>E</b>	Spinous processes undetectable, flesh creating a very convex profile, very broad shoulder area
<b>U</b>	Spinous processes just detectable, flesh beginning to create a convex profile
<b>R</b>	Spinous processes less prominent with flesh creating a straight profile under the hand
<b>O</b>	Spinous processes still prominent, less concave with some evidence of flesh beginning to fill the hand
<b>P</b>	Very prominent spinous processes evident, very concave profile to centre of hand

## Handling Animals with Care

Careful handling of live sheep is important to reduce stress and avoid carcase damage that will reduce the value of the carcase. Sheep bruise easily, particularly young lambs. Bruises require trimming which reduces weight as well as the commercial saleability of the carcase/cut.

To avoid bruising do not:

- **Ever** handle and move sheep or lambs by grabbing wool
- Allow sheep to be trampled during transport
- Allow sheep to trample over each other in races during handling or selection
- Permit any sharp objects in races/trailers/gates etc.



*Example of bruising due to wool pulling*

Good handling not only reduces stress on animals and the risk of carcase damage, it also cuts the risk of occupational injuries to staff (handling sheep frequently involves bending over rases, stooping and lifting and turning).

Well designed handling systems can reduce overall handling time and improve the efficiency of farm operations.



## Dirty Fleeces

Clean fleeces are essential - dirty sheep cannot be slaughtered under the Food Standards Agency (FSA) enforced clean livestock policy. A dirty sheep skin is worth less than a clean one and it can contaminate the carcase and this can give rise to public health problems.

## Clean livestock

FSA score 1 and 2 are acceptable, 3, 4 and 5 are unacceptable.



# Making Marketing Decisions

In order to maximise returns, when sheep/lambs are reaching the condition considered ideal for the target market being considered (i.e whether local butchers, domestic supermarkets or export) the producer needs to:

- Monitor market signals e.g. comparative daily, weekly, regional, deadweight/liveweight price reports
- Consider the route to the market. Whether selling direct to the abattoir or via an auction market, each route will incur different costs. These marketing costs need to be understood if the best returns are to be achieved.

## Carcase Quality

Carcase classification provides a UK recognised measure of a number of the key attributes that influence carcass quality, which can be used to help target market requirements.

*(For more information see Technical Note 2 on page 26).*

## Target Markets

Most outlets, whether export or domestic (supermarkets or local butchers), produce weekly payment schedules using carcass classification to define the key attributes of product required.



## Food Chain Information

Providing Food Chain Information (FCI) has been a legal requirement since 1 January 2010 when sheep are sent for slaughter.

The 'minimum elements' of FCI consist of statements to confirm that:

- a. the holding is not under movement restrictions for animal disease or public health reasons
- b. withdrawal periods have been observed for all veterinary medicines and other treatments administered to the animals while in this and previous holdings
- c. that the livestock as far as the producer is aware, are fit and healthy and not showing any signs of a disease or condition that may affect food safety.

Currently these are most commonly appended to the movement license and will accompany the animals when they are being transported. It is good practice however, to send the information before the animals are consigned so as to pre warn the abattoir and its official veterinarian of any issues to watch out for (especially important if the animals have been injured prior to consignment).

In specific instances additional information may be requested.

## Market Signals

HCC provides extensive marketing information on a daily, weekly and annual basis. Information can be obtained from the following sources:

- Website [www.hccmpw.org.uk](http://www.hccmpw.org.uk)
- Printed information e.g. Market Bulletins direct from HCC
- Text messages Market price information sent to your mobile phone from HCC
- Industry meetings HCC staff available to disseminate latest market information

Armed with the knowledge of the quality of stock they produce, market requirements and pricing schedules, producers can then develop market strategies which maximise their returns.

# Terms and Conditions And Other Factors That Can Affect Returns

### Killing out percentages and carcass weight

The killing out percentage (KO%) is the amount of a live animal that ends up as carcass (including muscle, sinew, fat and bone), but it is not an indicator of quality.

Slaughterhouse operators/butchers often refer to 'meat yield'. This is the proportion of saleable meat from the carcass.

### Factors which affect carcass weight

#### Dressing Specifications

Abattoirs may choose from two dressing specifications agreed by the industry, or they can adopt their own specification; the two agreed specifications are:

- MLC Standard Specification
- Tail Removed Specification

#### MLC Standard Specification

This requires the removal of specific parts of the lamb before weighing. The parts to be removed are the fleece/skin, the head (leaving all the spine), the forefeet at the knee and the hind feet at the hock, the paunch and guts (leaving the diaphragm), the caul and gut fat, the liver, spleen, heart and lungs (known as the pluck), the heart fat, the sweetbreads and the genito-urinary organs (but not kidneys and kidney fat).

#### Tail Removed Specification

This specification includes the removal of all parts set in the MLC specification together with the removal of the tail at the fifth sacral vertebra (equates to an average loss of 0.2kg per carcass for a 20kg carcass).



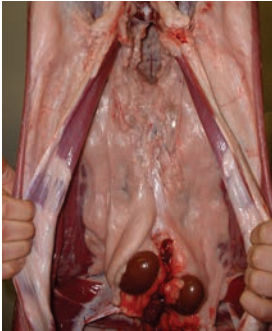
*Tail on*

*Tail off*

Any other dressing specification is referred to as "Company Specification" and its definition should be sought from the abattoir.



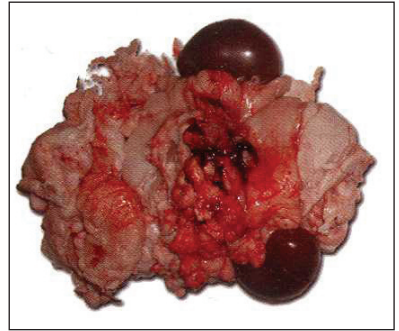
It is extremely important that a farmer understands how a carcass is to be dressed before it is weighed, as it can have a proportionally far greater affect on the value of a lamb/sheep than is the case with cattle and pigs (e.g. a 'Company specification sometimes used is excluding kidney knob and channel fat – this equates to a reduction in carcass weight of about 0.5kg – the trimming of neck and belly flaps also affects carcasses weight and can be part of a 'Company specification').



*Carcasses with Kidney Knob and Channel Fat (KKCF) still attached*



*Carcasses with KKCF removed*



*KKCF*

### Other terms and conditions

Dressing specification is only one of the terms and conditions of sale that can affect the farmer's returns from his animals. Other terms and conditions of sale include:

- maximum payment weights - some abattoirs only pay up to 21kg.
- rounding weights down to the nearest 0.2 or 0.5kg.
- using 'hot weight' rebates to establish the 'cold carcass' payment weight.

### Hot Weight Rebates

Hot carcass weights are applied to carcasses weighed within one hour of slaughter and it is on this rebated weight that producers are paid. The table shows the difference between different scale calibrations:

Scales calibrated to 0.2kg		Scales calibrated to 0.5kg	
Hot Wt (kg)	Rebate (kg)	Hot Wt (kg)	Rebate (kg)
25.4 and under	0.5	25.5 and under	0.5
25.6 and over	1.0	26.0 and over	1.0

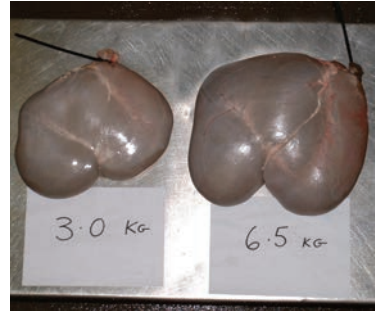
It is extremely important that a farmer understands the terms and conditions being offered by the abattoir for the purchase of livestock and not rely on the quoted headline base price as being indicative of the best returns.

# 18 Terms and Conditions And Other Factors

## Other factors affecting carcass weight / killing out percentage (KO%)

The KO% for sheep and lambs can vary very significantly depending on a number of factors discussed below, a typical range would be 45% - 50%.

- Milk fed lambs generally have a higher KO% than weaned lambs
- Stomach content at live weighing - empty stomach gives a higher KO%, and is less likely to contaminate the carcass at the point of evisceration on the sheep dressing line
- Seasonal variation - on average, spring lambs have a higher KO% than hoggets
- Sex - females generally have a higher KO% than entire males
- Fatter lambs generally have a higher KO% than lean lambs, but any increase in return from a higher carcass weight may be mitigated by penalties for the lambs being over fat
- Breed and genetic performance of the sire and dam within a breed
- Lambs with long tails, testicles, or horns have a lower KO%
- Fleece length and type - heavier fleeces result in lower KO%. Mud on the belly wool can account for over 2 kg
- Weather factors i.e. wet or dry, will affect the weight of the fleece and this will impact on KO%
- Age; as an animal matures the weight of its fleece and other parts will increase. On average spring lambs have a higher KO% than old season lambs. Ewe lambs that are 'in lamb' at slaughter will also have a lower KO%
- Bruising through poor handling or carcass damage through infected needles, will reduce the carcass weight as trimming will occur.



*Two paunches - 3.5kgs difference in weight!*



*Trimming due to injection abscess*



*Example of bruising due to wool pulling*

# Eating Quality

## Why is eating quality important? – The Consumer View

Purchasing decisions are generally based on price, visual appearance and to fulfill the requirements of a particular meal. Repeat purchases, and hence the profitability of individual businesses, are reliant on the product giving a satisfactory eating experience.

Lamb is generally considered to be of good eating quality. The main criticism of lamb is in relation to its perceived fattiness. Lamb fat is particularly disliked by some because of its high melting point and sticky feel in the mouth.

## Pre-slaughter factors influencing eating quality

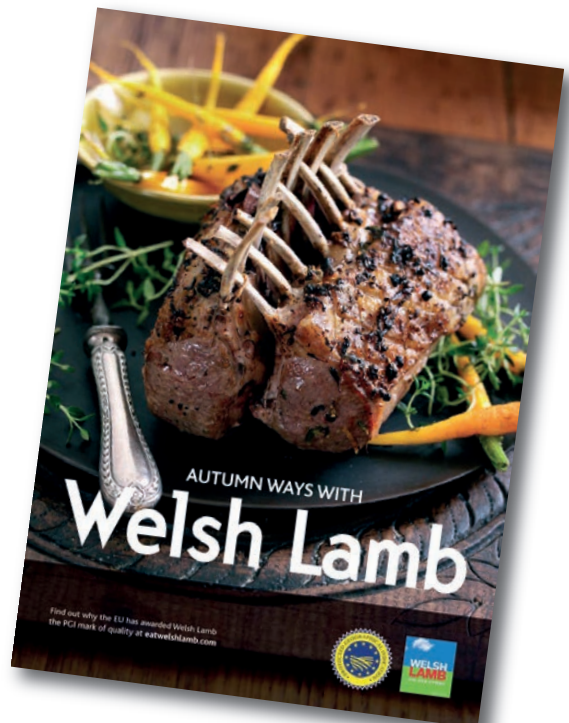
### Breed

Breed does not appear to have a significant impact on eating quality of lamb.

### Sex

- Overall differences between ram lambs, ewe lambs and wethers are small.
- It is advisable to utilise ram lambs only when finishing can be achieved by 5-6 months of age. Older ram lambs tend to have a stronger flavour which is not liked by most consumers.

*(For more information see Technical Note 3.2 on page 27).*



## 20 Eating Quality

### Diet

- Diet can influence lamb flavour with the stronger flavour of grass fed lamb being generally preferred by UK consumers.
- Diet has little effect on tenderness, but the supplementation of forage diets with concentrates can produce unwanted fat characteristics.
- Vitamin E in the diet of sheep (at 300IU [200mg] per kg dry matter) can extend shelf life and protect flavour in lambs fed on concentrate diets.

### Age / seasonality

The general rule is that the older the lamb the tougher the meat.

Research has demonstrated that there is a seasonal decline in tenderness with hoggets (winter lamb) generally producing tougher meat than main season lambs.

However, meat from younger animals tends to have a less intense flavour than meat from older animals, for example lamb compared with mutton.



### Fatness

There is a weak relationship between fatness and eating quality, according to research. But many consumers still perceive lamb as a fatty meat. While a level of fat has small benefits in terms of juiciness and tenderness, this needs to be balanced against the consumer demand for lean meat. A lean, consistent product, with a pleasing visual appearance should be the goal.

Aim for a minimum fat class of 2 and a maximum of 3H.

### Pre slaughter handling/transport

Careful handling of livestock prior to slaughter reduces the risk of stress. Stressed lambs use up their muscle energy reserves prior to slaughter. As a consequence the meat can be very dark, making it unattractive, of poor flavour and more prone to bacterial growth, thus reducing shelf life. This is a particular problem if lambs are underfed.

*(For more information see Technical Note 3 on page 27).*

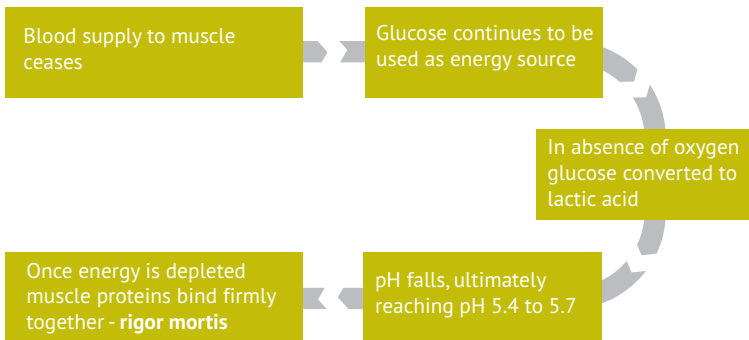
## Post slaughter factors influencing eating quality

### Stunning and slaughter

After stunning, sheep have to be stuck (bled) within 15 seconds, but a time of less than 10 seconds is recommended to reduce blood splash. The stunning and sticking method does not have an important influence on meat quality, unless it is carried out improperly, when traumatic stress can lead to the problems described on page 20.

### The conversion of muscle to meat

Following slaughter, muscle undergoes a number of changes that are important in determining visual appeal and ultimate meat quality. These changes are illustrated in the diagram below.



The rate at which a muscle goes into rigor mortis is influenced by a number of factors:

- energy stores within muscle when the animal leaves the farm
- the depletion of energy stores during transport and lairage
- stimulation of the metabolic processes via pre-slaughter stress
- stimulation of muscular activity during slaughtering
- the rate at which the muscle is cooled

(For more information see *Technical Note 4.1* on page 29).

## 22 Eating Quality

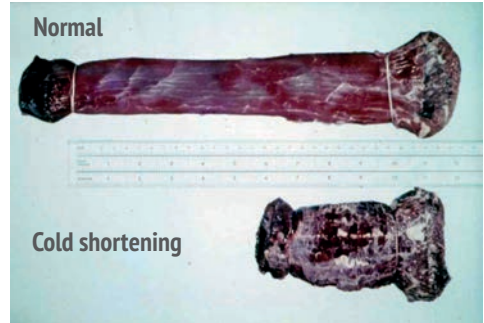
### Chilling regimes

Contraction of the muscle prior to rigor mortis ("shortening") results in increased meat toughness. Lamb carcasses are particularly susceptible to shortening resulting from chilling too rapidly. Chilling methods should be monitored in order to prevent toughness due to shortening in leaner carcasses, and extremely lean carcasses should be avoided.

### Electrical stimulation

Electrical stimulation is used in some meat plants to improve eating quality. An electrical current is applied to the carcass after slaughter which stimulates the muscles to contract and hence use up energy. This accelerates the onset of rigor mortis enabling chilling to take place earlier. High voltage electrical stimulation increases tenderness more than low voltage.

*(For more information see Technical Note 4.2 on page 30).*



*Electrical stimulation*



*Meat inspector*

### Carcass suspension method

The tenderness of the leg and loin muscles of lamb are increased by suspension of the carcass from the hip rather than the achilles tendon. This is as a result of stretching the muscles, thus avoiding contraction prior to rigor mortis.

*(For more information see Technical Note 4.3 on page 31).*

### Maturation (ageing)

Extended storage of lamb increases tenderness and is particularly useful in improving the tenderness of meat from older animals. Ageing tenderisation occurs as enzymes, naturally present within the meat, break down the protein. Lamb loin generally benefits from ageing to a greater extent than other parts of the carcass.

Ageing lamb, either in a carcass form or in vacuum packs for a minimum of 7 days and an optimum of 10 days will improve tenderness.

*(For more information see Technical Note 4.4 on page 31).*

### Cooking

Cuts higher in connective tissue benefit from moist cooking methods. When using dry methods (grilling, frying and roasting), overcooking can result in drying out and a toughening of the meat.

The flavour of meat develops during cooking, as a result of the effects of heat on the proteins, fats and sugars present in muscle and fat. The chemical reactions that cause this are complex, but during cooking, the number and speed will increase if cooking

temperature is raised and the internal temperature of the meat increases. This effect is why well-done steaks and joints have a more intense flavour than those that are lightly done.

However, too high a temperature of too long a period will affect the tenderness of the meat. Searing steaks on the outside quickly at high temperatures, is one way of intensifying flavour and retaining tenderness within meat that has tenderness attributes – cooking is a skill, a science and an art!

Carcass suspension method



Achilles

Hip

### Butchery / Meat Yield

Whether selling live or dead weight, producer returns are ultimately reliant on the value of the carcass. This value is directly related to the yield and the distribution of saleable meat.

- In order to meet consumer requirements, over-fat carcasses need to be trimmed. Trimming of excess fat reduces meat yield and increases processing costs.
- A typical lamb carcass (R3L), butchered to produce predominately bone-in cuts, yields approximately 80 to 88% saleable meat (depending upon the butchery technique). Reducing the fat to class 2 increases the meat yield by approximately 1.5%. Increasing the fat to class 4L decreases the meat yield by approximately 2.0%.
- It may not always be possible to remove all excess fat from individual cuts (if there is an excessive amount of intra muscular fat). Even after trimming, cuts from fatter carcasses may still have a higher than desirable fat content. As a consequence they will be visually less appealing to the consumer.
- Conformation has less impact on meat yield compared to fatness, due to the need to trim excess fat from over fat carcasses.
- The main influence of conformation is the distribution of meat within a carcass. Better conformation carcasses generally will have more of their meat in the higher value hindquarter cuts.

*(For more information see Technical Note 5 on page 32).*



*Fat class 2*



*Fat class 4L*



# Technical Notes

## 1. Breed Improvement

Seven standard Estimated Breeding Values (EBVs) are calculated for each animal.

EBV	A brief explanation
8-week weight	Selection on high EBVs for these traits will result in faster growing lambs.
Scan weight	Selection for high growth rate also tends to result in an overall increase in mature size.
Muscle depth	Choosing animals with high muscle depth EBVs will increase lamb muscularity and hence the lean meat content of the carcase.
Fat depth	Selection on low fat depth EBVs will result in less fat in the carcase.
Mature size	Choosing animals with high EBVs for this trait will increase mature size.
Litter size	Selection on high EBVs will increase litter size.
Maternal ability	This is the maternal component of the 8-week weight measurement. The higher the EBV the better a ram's ewe lambs will perform as mothers (e.g. milking ability).

### Selection Indexes

As well as using individual trait EBVs, five selection indexes have been designed to help breeders improve several traits at once. The different EBV traits are weighted according to their economic importance in the index. Which of the five selection indexes are used depends on the breeders' objectives:

### Conclusion

Compared to Ram A, Ram B will produce lambs that grow faster (11.8), are better fleshed (4.15) and have less fat (-0.13).

*(For more information see HCC's Ram Buyers Guide.)*

### Example of two rams with Terminal Sire Index

EBVs	Ram A	Ram B
8 week weight (kg)	4.48	4.96
Mature weight (kg)	3.3	3.94
Litter size	-0.03	0.04
Maternal ability (kg)	1.61	1.93
Scan weight (kg)	8.9	11.8
Muscle depth (mm)	2.37	4.15
Fat depth (mm)	0.69	-0.13
Terminal index	308	464

## 2. Sheep Carcase Classification

### How production systems affect classification?

Conformation and fatness are affected by the production system used. Identical animals put through different systems will have different characteristics, but some characteristics are more controllable than others. The relationship between different factors is explained below:-

- **Age affects conformation**

Different breeds and crosses affect age at slaughter and conformation. If you compare changes within a breed, age affects conformation. In spring lambs conformation tends to increase as the lambs get older, so very fast grown creep fed lambs will tend to be of poorer conformation than those of the same breeding finished at 5-6 months.

Old season lambs tend to be poorer in conformation than those of the same breeding finished at 6-8 months old.

- **Fat classification is independent of age**

There is no relationship between age and fat classification. This is good news because it means producers, in general, do a good job of managing finishing condition. The ease with which lambs fatten increases as they get older. This is because their physiology changes - in the most part related to sexual maturity. A rough guide is that when lambs reach around 60% of their final adult weight, they fatten more rapidly.

- **Sex and fatness**

Classification for fatness focuses on subcutaneous fat and the same system applies for males, females and castrates. There is evidence to show that fat inside muscles differ between the sexes. This means that ewe and wether lambs at a given classification may have a higher proportion of fat than ram lambs.

- **Sex and conformation**

The sex of a lamb does not have a significant effect on conformation score. Rams, ewes and wethers from a given breed or cross have very similar conformation scores.



### 3. Pre-slaughter factors influencing eating quality

#### Diet

The composition of the diet influences the products of digestion and hence meat odour, flavour and fat characteristics. Generally, stronger lamb flavour is imparted by forage finishing and this is preferred by UK consumers.

The following can have detrimental effects on lamb flavour:

- Legumes (particularly lucerne but also white clover)
- brassicas
- oat pasture
- maize silage
- Soya

Where these are used in the diet lambs should be grazed on grass for a period of at least 7 days prior to slaughter to restore normal flavour.

If the energy reserves of the muscle are low prior to slaughter the degree of glycolysis which can occur is diminished and the ultimate pH will not be as low as in normal muscle with higher energy reserves. If the pH is greater than 6.0 the muscle will have a dark and dry appearance with a firm texture. This condition is termed Dark Firm Dry meat (DFD), sometimes 'dark-cutting' meat, which is rarely seen in lamb.

One of the attributes that consumers use to select meat is colour and appearance, and they will often avoid very dark meat.

A combination of reduced oxygen penetration into the meat and lower light reflectance results in less visible red oxymyoglobin pigment and hence the dark appearance. The dryness is thought to be a consequence of the higher pH leading to a higher water holding capacity of the myofibrillar proteins. DFD meat is normally found to be more tender, but the higher pH also leads to a better environment for the growth of spoilage bacteria and consequently a poorer shelf-life.

### 4. Post-slaughter factors influencing eating quality

Before slaughter the muscles of the animal are generating energy through biochemical pathways that use oxygen. Following bleeding out there is no longer a blood supply to the muscles. This has two effects:

- There is no longer any oxygen
- The products of metabolism cannot be removed via the bloodstream and therefore accumulate in the muscle.

In the absence of oxygen, the muscle attempts to maintain cellular energy levels. Muscle is capable of producing energy from glucose without the need for oxygen (glycolysis). This anaerobic metabolism produces lactic acid. The acid accumulates and gradually reduces the pH of the muscle from about 7.2 in a normal resting live muscle to an ultimate pH of about 5.4 to 5.7 in normal meat. Muscle can generate energy from glucose until all the glucose is used up or until the accumulation of acid in the muscle destroys the metabolic processes.

This ability to generate energy even after slaughter means that muscle can continue to contract for a considerable time (e.g. in

response to an external electrical stimulation) after the animal's central nervous system is dead. Different muscles, or even different muscle fibre cells within a muscle, can continue to function for varying lengths of time.

The main bulk of the muscle is made up of the proteins myosin and actin. When all of the available energy is exhausted, the myosin and actin molecules bind firmly together and the muscle loses its extensibility and flexibility. This is rigor mortis.

The rate at which a muscle will go into rigor mortis can be influenced by a large number of factors, key ones are:

- Energy stores available when an animal leaves the farm
- The extent to which these stores are depleted during transport and lairage
- The stimulation of the metabolic process via pre slaughter stress
- Stimulation of muscular activity during the slaughtering process and the rate at which muscle is cooled



#### 4.1 Chilling regimes

Most muscles are under tension when the skeleton of the carcase is in its normal standing posture. They will contract (shorten) naturally as the muscle goes into rigor mortis if it is not restrained from doing so. If muscle is restrained it will develop tension as it goes into rigor but will not be able to shorten in its overall length. The extent to which muscles are able to shorten depends on the remaining energy available, the load on the muscle and the temperature of the muscle when these events occur. Shortened muscle is usually significantly tougher because of the overlapping muscle fibres which are densely packed.

Temperature has an important effect on the ability to shorten during rigor. For shortening to be minimised rigor should occur at about 15°C. This can never be achieved in practice, for all muscle fibres because of the different rates of cooling in different locations of the carcase and the different rates of rigor development in different fibres. It is however a useful guideline.

Cold shortening occurs if the muscle is exposed to low temperature (<10°C) prior to the development of rigor. Under these conditions the muscle spontaneously contracts and, since it does so at higher levels of pH than rigor shortening, the degree of contraction (and toughening) can be considerable.

The best way to monitor muscle shortening is to measure pH levels in conjunction with the carcase temperature.

Hot shortening is the shortening that occurs with rigor above 20°C. This occurs as the energy supply is being exhausted and it is generally quite weak. Hot shortening has the

potential to affect meat quality but its importance is still debated. It can occur if high voltage stimulation, used to improve tenderness is too rigorous.

The level of pH is a good indication of the onset of rigor and the combination of muscle temperature and pH can predict cold shortening toughness problems.



### 4.2 Electrical stimulation (ES)

ES can be an effective means of improving tenderness of lamb. ES was developed primarily to allow rapid chilling without the risk of cold shortening. The electrical current applied stimulates the muscles to contract and hence use up energy. This accelerates the onset of rigor mortis enabling chilling to take place earlier. It also appears that High Voltage has additional benefits in tenderness, perhaps through accelerating the ageing process or direct physical damage to the muscle fibre structure.

If low voltage stimulation is used it must be applied whilst the nervous system is still intact. In practice this means immediately after bleeding. Good contact (ie electrode positioning) and timing are critical for low voltage stimulation to be effective. This means that it is a less reliable approach than high voltage stimulation.

There is also the risk of a toughening effect of Low Voltage Electrical Stimulation (LVES) due to hot shortening. Where LVES is effective it seems to simply prevent cold shortening.

High voltage stimulation does not depend on an intact nervous system. It is applied later on the slaughterline (after pelting) and therefore electrode contact is easier and the high voltage makes positioning less critical. Because it is applied later the carcass has cooled to an extent where hot shortening is not induced by stimulation.



#### 4.3 Carcase suspension method

It is clear from the section on chilling that the state of contraction of muscles is a significant factor in determining eating quality. Muscular contraction post mortem is moderated by the attachment of the muscles

to the skeleton. The tension imposed on any individual muscle in the carcase depends on the position of the skeleton.

Hip suspension stretches the muscles of the leg and loin yielding tenderness benefits.



#### 4.4 Maturation (ageing)

The action of enzymes that damage or destroy proteins (proteolytic enzymes) in post-mortem muscle is a highly significant source of variation in the tenderness of meat. The enzymes primarily responsible for the tenderisation process are a family of calcium activated enzymes, called the calpains, and their inhibitor calpastatin.

Generally proteolytic degradation and hence tenderisation is considered to occur more

quickly in white fibres, and muscles made up predominantly of these, than in red fibres/muscle. This is reflected in differences in the rate of tenderisation, and hence optimum ageing time, between muscles within a carcase and between the species.

The enzymes are more active at pH<sup>7</sup> and at higher temperatures, therefore their greatest level of activity is around the time of rigor when sufficiently high levels of calcium may become available.

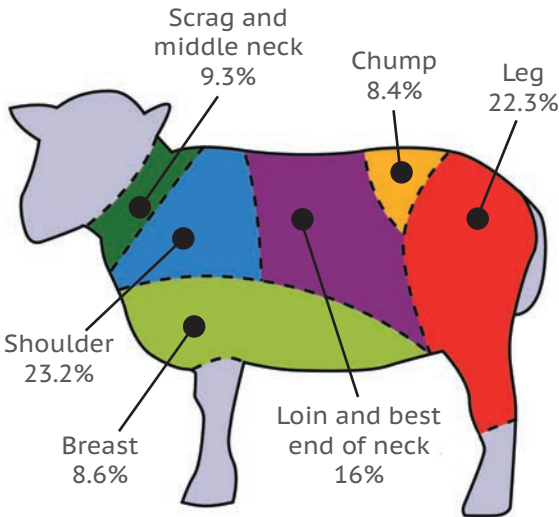
## 5. Butchery/Meat Yield

Lamb has historically been perceived as a traditional bone-in product lacking in the versatility needed to meet the needs of the modern consumer. However, changes in butchery practices now enable a range of boneless products to be produced, which are

quick and easy to cook. Although the removal of bone adds value to the final product, the price achieved needs to compensate for the reduction in overall saleable yield and the increase in processing and waste disposal costs.

### Yield - Traditional Lamb Cuts

Average yield of prepared bone in cuts and joints as a percentage of the carcase.



	%Yield
Leg	22.3
Chump	8.4
Scrag	2.5
Shoulder	23.2
Breast	8.6
Middle neck	6.8
Loin	9.0
Best end of neck	7.0
<b>Saleable Cuts</b>	<b>87.8</b>
Fat trim	6.9
Bone and waste trim	4.8
Kidney	0.5
<b>Total</b>	<b>100</b>



With bone-in lamb the portion size can sometimes be an issue. Whilst there are economic advantages of producing heavier carcasses, the unit price of, for example, whole or half legs increases proportionately to the weight. This may then put the product outside some consumers' price range. Butchery methods which remove individual muscles, rather than the traditional methods, have been developed and are now used by industry. This results in smaller cuts from which fat is more easily removed.

Regardless of the butchery approach the level of fat in the carcass has a significant impact on saleable meat. Most consumers require product with a minimum amount of fat. With an increasing proportion of meat being purchased from self-service multiple retailer display cabinets, consumers are able to be selective. Product with unacceptable fat levels will often remain on the shelf.

Excess fat therefore needs to be removed during the butchery process which adds to processing costs.

Better conformation carcasses will have a higher proportion of their saleable meat in the higher value hindquarter cuts. High value cuts, e.g. loin, chump and leg, represent approximately 45% of the carcass.



### Further information

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